Lesson 7:
Magnetic Field and Life

Students explore magnetic forces, fields, and the relationship between electricity. They use this information to infer how the Earth generates a protective magnetic field.

Main Lesson Concept: The movement of the liquid outer core as the Earth rotates causes a magnetic field that, with the atmosphere, protects us from solar wind and space particles.

Scientific Question: How is the Earth protected from solar particles?

Objectives	Standards
• Students will observe and describe magnetic forces and fields. • Students will use the inquiry process to develop a temporary magnet using electricity and will observe and describe the relationship between electricity and magnetism. • Students will describe the dangers that the Sun presents to human life and will illustrate and explain how the Earth is protected from these dangers by the atmosphere and Earth's magnetic field.	**Meets**: NSES: B (K-4) #3.4 2061: 4G (6-8) #3 **Partially Meets:** 2061: 4G (9-12) #2, #5 NSES: B (K-4) #3.3

Assessment	Abstract of Lesson
Inquiry write-ups, illustrations, and answers to Astro Journal questions.	Students research and discuss the dangers of solar wind and space particles. They then predict and observe magnetic forces and fields to conclude that magnets exert a force. Students use the inquiry process to explore the creation of a magnet using electricity. They conclude that magnetism and electricity are related and that an electric current can create a temporary magnetic force. They apply this concept in a discussion that links to Earth's magnetic field, which helps to protect the Earth from harmful solar wind and space particles.

Prerequisite Concepts

- All matter is made up of atoms. The atoms of any element are alike but are different from atoms of other elements. (Atmosphere Lesson 2)
- The Sun produces radiation that is harmful to life. (Atmosphere Lesson 6)
- The ozone layer in our atmosphere protects life on Earth from harmful ultraviolet radiation. (Atmosphere Lesson 6)
- Humans need the following geologic conditions (Geology Lesson 1):
  - Liquid outer core (coupled with the planet's rotation and a thick atmosphere)
  - Viscous mantle (slow motion)
  - Slow motion of crust and upper mantle (lithosphere) of 3-5 cm/year
- Magnets attract and repel each other and certain kinds of other materials (NSES: B (K-4) #3.4)
- Without touching them, a magnet pulls on all things made of iron and either pushes or pulls on other magnets. (2061: 4G (3-5) #2)
- Changes in speed or direction of motion are caused by forces. The greater the force is, the greater the change in motion will be. The more massive an object is, the less effect a given force will have. (2061: 4F (3-5) #1)
- Some materials, such as metals, allow heat or electricity to flow through them very easily, while others, such as wood, do not easily allow heat or electricity to flow through them.

Major Concepts

- The Sun produces the solar wind that is made of fast-moving particles that could harm us by causing cancer and mutations.
- Magnets can exert a force on each other.
- Magnets generate a force around themselves called a magnetic field.
- Magnetism is caused when atoms are all pointed in the same direction.
- As the Earth rotates, it causes the outer core to move, which is possible because the outer core is liquid.
- The amount of movement of this outer core is enough to generate a strong magnetic field around the Earth.
- This magnetic field and the Earth's atmosphere shield the Earth from the harmful solar wind.
- Scientists do not agree whether or not life could survive on Earth without its magnetic field, as our atmosphere may provide sufficient protection.

Suggested Timeline (45-minute periods):
Day 1: Engage and Explore Part 1 sections
Day 2: Explain Part 1 and Extend Part 1 sections
Day 3: Explore Part 2 and Explain Part 2 sections
Day 4: Extend Part 2 and Evaluate sections (35 minutes)

Materials and Equipment:
- A class set of Astro Journal Lesson 7
- Chart paper
- 1 to 30 computers with Internet browser and Internet connection (optional)
- Balloon(s) (optional for demonstrating electrical charge in Explore Part 2 section)

Exploring Magnets Activity (each group or individual will need the following):
- 2 small magnets for each group of students

Exploring Magnets Activity--Magnetic Field Demonstration (teacher demo will need the following):
- Bar magnets or cow magnet
- 15 to 30 cubic centimeters (2-3 tablespoons) iron filings
- Plate of glass (at least 6" x 6") or heavy duty vinyl sheet protector 8.5" x 11"
- Magnetic field projectual (optional alternative to the above materials)
- Overhead projector

Note to Teacher: Bar magnets, iron filings, and magnetic field projectuals can be found at most science educational supply stores such as:
Educational Innovations: http://www.teachersource.com
Sargent-Welch: http://www.sargentwelch.com
Indigo Instruments: http://www.indigo.com
Fisher Science Education: http://www.fisheredu.com
NADA Scientific: http://www.nadasci.com

Making a Magnet Activity (each individual or pair will need the following):
- 1 long nail
- 1 tablespoon iron filings
- Approximately 30 centimeters copper wire
- 1 "D" battery
- Wire made of different metals and thicknesses, nails of different materials, and batteries of different materials and sizes (optional for Opportunity for Open Inquiry variation in Explore Part 2)

Preparation:

- Duplicate a class set of Astro Journals.
- Gather materials.
- Prepare classroom. (Make sure there is room for the acting out of magnetism in Extend/Apply Part 1.)
- Verify links on harmful solar radiation and auroras.
- Prepare chart paper with major concept of the lesson to post at the end of the lesson.

Differentiation:

Accommodations
For students who may have special needs, have them work with a partner on their Astro Journal writing or report orally to the teacher. The investigations and kinesthetic activities included in this lesson will be helpful for these students in gaining an understanding of the main concepts of the lesson.

Advanced Extensions
Have students watch the movie "The Core" and identify the correct information and the misconceptions that this movie portrays about Earth's magnetic field.

Engage (approximately 15 minutes not including the optional solar particle research activity)

1. **Draw on students' prior knowledge of the dangers from the Sun.**
   - Question: What did we learn in the Atmosphere lessons about how the Sun can be harmful to humans?
   - *Answer: The Sun produces ultraviolet radiation, which can give us sunburns or skin cancer.*
   - Question: How are we protected from ultraviolet radiation?
   - *Answer: Ozone in our atmosphere prevents much of the ultraviolet radiation from reaching the Earth's surface. We use sunscreen, wear special sunglasses, and stay out of the Sun to protect us from the small amount of ultraviolet radiation that reaches the Earth's surface.*
   - Question: Do you think that ultraviolet radiation is the only danger that the Sun poses to life on Earth? Explain.
   - *Answer: (Students may have heard of solar wind, solar storms, solar flares, or may have heard that astronauts need protection from radiation when they are in space.)*

   Note to Teacher: You may consider having students do some research on the Internet or in the library on solar wind, solar flares, or other harmful solar radiation to learn more about them. To learn about the effect of solar flares on astronauts, students might search "solar flares and astronauts" in a search engine. Then the following discussion can be used to bring out the information that students find during their research. The following are some online age appropriate resources with more information in this area:
   - What is a Solar Flare?
     http://hesperia.gsfc.nasa.gov/sftheory/flare.htm
   - What are the Odds?
     http://ds9.ssl.berkeley.edu/LWS_GEMS/5/what.htm
   - Solar Flares Could Delay Endeavor Spacewalks
     http://www.space.com/missionlaunches/flares_spacewalk_010416.html
   - The Solar Wind
     http://science.msfc.nasa.gov/ssl/pad/solar/sun_wind.htm

2. Discuss harmful effects of solar wind and solar flares.

- Say: The Sun produces other harmful radiation besides ultraviolet radiation. The Sun also produces solar particles that can be very harmful to us in high dosages.

- Question: How does the Sun release particles?
- *Answer: The Sun produces a solar wind and occasionally produces solar flares.*

- Question: What is solar wind? How is it produced?
- *Answer: The solar wind consists of charged particles that stream off of the Sun in all directions at speeds of about 400 km/s (about 1 million miles per hour). The temperature of the Sun's corona is so hot that the Sun's gravity cannot hold on to it.*

- Question: What is a solar flare? How powerful is a solar flare?
- *Answer: A solar flare occurs when magnetic energy that has built up in the solar atmosphere is suddenly released. The amount of energy released is the equivalent of millions of 100-megaton hydrogen bombs exploding at the same time. This is ten million times greater than the energy released from a volcanic explosion.*

- Question: What can high dosages of solar particles do to people?
- *Answer: High levels of solar particles can cause radiation sickness—a loss of appetite, vomiting, and diarrhea. Higher doses of radiation can damage cells and tissue leading to cancer or cataracts.*

3. Introduce the purpose of the lesson and the Scientific Question.

- Say: Despite these strong storms, we see little effect down on Earth's surface. Sometimes, we experience disruptions to our communication systems and interference on our televisions and radios.

- Question: How are we protected from the bombardment of solar particles and radiation?
- *Answer: (Allow students to share their ideas about this. They will likely identify our atmosphere as a protector, since our atmosphere protects us from ultraviolet radiation—although the method of protection from ultraviolet radiation is different than that for solar particles.)*

- Question: Our atmosphere, in fact, plays an important role in protecting us from solar radiation and particles. However, there is something else that also protects the Earth.

- Say: Today we are going to look at how Earth's structure plays a role in protecting the Earth from solar particles.

- Say: The Scientific Question we will be investigating is:
  - How is the Earth protected from solar particles?

- Have students record their hypothesis/prediction in their Astro Journals.

Explore

Part 1 - (approximately 30 minutes)

1. **Draw on students' knowledge of magnets from previous experiences.**
   - Question: What do you know about magnets?
   - *Answer: (Allow students to share their ideas about this. Students may say that magnets stick to metal things and to each other.)*

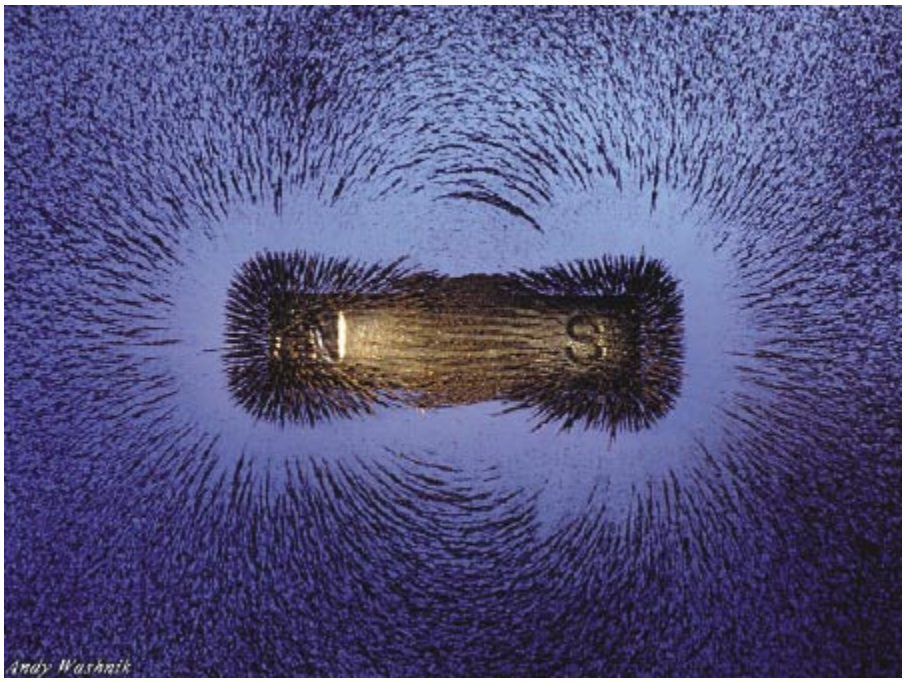
   Note to Teacher: Research by Rosalind Driver (Driver, et al, p126-127) and Arnold Arons (Arons, p151) reveal that many students haven't manipulated magnets nor have they felt the effects with their own muscles and that very few students have experienced repulsion of two magnets. The following hands-on experiences are, thus, very important for students.

MISCONCEPTION: Many people believe that magnets attract all metals; however, magnets will only attract metals with a particular atomic structure, such as iron, steel, cobalt, and nickel. Ask students what kinds of materials are attracted by magnets. If they say all metals are attracted, have them test this hypothesis with magnets and materials of different kinds of metal.

2. **Introduce the Exploring Magnets Activity.**
   (The following activity and image is adapted from NASA Goddard Space Flight Center's "Mapquest: Mapping Magnetic Influence" lesson available at http://son.nasa.gov/pdf/Mapping_Magnetic_Influence.pdf)

   - Say: In the next activity, you will look at the properties of magnets.
   - Tell students that they will be observing magnets and drawing some conclusions about the properties of magnets.
   - In the Exploring Magnets Activity section of their Astro Journals, have students fill in their predictions of how they think magnets will behave with opposite sides toward each other, like sides toward each other, and what the pattern of iron filings will be when sprinkled on a magnet.
   - Have students share their predictions about magnet behavior. List student predictions on the board and discuss their explanations.
   - Give each individual or group of students two small magnets to experiment with.
   - Have students test each of their predictions and record their observations in their Astro Journals.

   Note to Teacher: For the iron filings test, you can project this using an overhead projector, if you prefer to do it as a demonstration. Place a bar magnet on the overhead projector and a piece of glass on top of the bar magnet. Gently sprinkle fine iron filings on the glass and tap it to allow the filings to line up with the magnetic field. Since this can be messy if the iron filings get onto the magnet, you can also confine the filings in an 8.5 x 11 vinyl sheet protector and place that on top of the magnet instead of the glass. Alternatively, you could use a magnetic field projectual purchased from a science educational supply store. The result should look like the image on the following page.



- Have students complete the Exploring Magnets Activity questions in the Results/Conclusions section of their Astro Journal.

Explain

Part 1 - (approximately 20 minutes)

1. Discuss with students their observations and conclusions about the Exploring Magnets Activity.

- Question: What did you observe and feel when you moved the north side of a magnet near the south side of another magnet?
- *Answer: The second magnet was pulled toward the first magnet until they were stuck together.*

- Question: What did you observe and feel when you moved the north side of a magnet near the north side of another magnet?
- *Answer: The second magnet was pushed away from the first magnet until it turned sideways or around.*

- Question: Did one magnet change the speed and direction of the second magnet? Explain.
- *Answer: Yes, the second magnet's speed changed from not moving at all to moving, and its direction was either pulled toward or pushed away from the other magnet.*

- Question: Was anything touching the iron filings and making them move into the pattern around the magnet?
- *Answer: No, nothing touched the iron filings to make them move into a pattern around the magnet.*

- Question: What caused the second magnet and iron filings to change speed and direction?
- *Answer: A force caused the second magnet and iron filings to change speed and direction.*

- Question: So what can we conclude about magnets?
- *Answer: We can conclude that magnets can exert a force on each other and on the iron filings.*

- Question: What kind of pattern did the iron filings make when dropped on a magnet?
- *Answer: The iron filings stuck around both sides of the magnet, left empty space around the whole magnet, and then formed a circular pattern outside of this empty space all around each side of the magnet. The iron filings seem to follow certain lines in arcs from one end of the magnet to the other.*

- Say: Scientists call this space around a magnet a "magnetic field."

Extend/Apply Part 1 (approximately 25 minutes)

1. Draw connections from the Exploring Magnets Activity to the Earth's magnetic field.

- Question: How easy was it to push two like poles of a magnet together?
- *Answer: It was difficult, sometimes impossible.*

- Question: What did the iron filings demonstrate?
- *Answer: The iron filings demonstrated the magnetic field generated around a magnet.*

- Question: How is this like the Earth?
- *Answer: In Geology Training, we saw that the Earth has a magnetic field.*

- Question: So how is the Earth protected from solar wind and particles?
- *Answer: The Earth's magnetic field and atmosphere protect the Earth from solar wind and space particles in the same way the magnet affects the iron filings.*

- Question: Where is it easiest for the iron filings to touch the magnet?
- *Answer: At the poles.*

- Question: So where do you think the Earth might be most vulnerable to solar wind and space particles?
- *Answer: At the north and south poles.*

- Say: In fact, you may have heard of the northern lights or aurora borealis, which can be seen in the north where solar wind and particles interact with our atmosphere.

Note to Teacher: For those who've never seen them, you may want to refer students to Web sites that show what the northern lights look like. Students may also be interested in learning more about the Earth's magnetic field. Some sites that have good images and information on auroras are:

- The Aurora Page http://www.geo.mtu.edu/weather/aurora
- Aurora's Northern Lights http://climate.gi.alaska.edu/Curtis/curtis.html
- The Aurora: Information and Images http://www.pfrr.alaska.edu/~pfrr/AURORA
- Auroras Presented by the Exploratorium http://www.exploratorium.edu/auroras
- Painted Sky: The Aurora http://www-istp.gsfc.nasa.gov/istp/outreach/auroras.html

Some sites that have good images and information on the Earth's magnetic field are:

- Exploration of the Earth's magnetosphere http://www.phy6.org/Education/Intro.html
- From Stargazers to Starships http://www-istp.gsfc.nasa.gov/stargaze/Sintro.htm
- NASA's Cosmic and Heliospheric Learning Center http://helios.gsfc.nasa.gov/magnet.html
- Plasma, Plasma, Everywhere http://science.nasa.gov/newhome/headlines/ast07sep99_1.htm

- Question: Is the Earth's magnetic field the only thing that protects it from solar wind and particles?
- *Answer: No, the Earth's atmosphere also protects the Earth.*

2. Discuss the cause of magnetism.

- Question: What causes magnets to exert a force?
- *Answer: (Allow students to discuss their ideas about this question.)*

- Question: In the Atmosphere lessons, what did we learn about what matter is made of?
- *Answer: We learned that all matter is made of atoms.*

- Question: Are all atoms alike?
- *Answer: All atoms of the same element such as oxygen or nitrogen are alike, but are different from atoms of other elements.*

- Say: Each atom has its own magnetic field (a north pole and a south pole). In certain substances like iron, when the atoms are all lined up in the same direction, their magnetic fields act together so that the entire piece of iron has a strong magnetic field.

Note to Teacher: It may be helpful for students to act out magnetism to gain a better sense of this phenomenon. Have individual students represent iron atoms while other students represent steel or other metals that are attracted to magnets. Have students representing iron atoms bring one arm in front with palm facing up to represent their "North" side, and have them bring the other arm behind them with palm facing down to represent their "South" side. Have students group together with everyone pointed in different directions. Tell students that when the atoms are all pointing in different directions, they are not magnetized so they don't exert a force on students representing steel, who stand still. Then have the students representing iron move so that all of their "North" sides are facing in the same direction. Explain that now they have formed a strong magnetic field and thus will attract certain other metals. Have the students representing steel move closer to the iron students until they are close enough to hold hands. They can grip hands or wrists to represent the magnetic attraction between them.

Explore

Part 2 - (approximately 35 minutes)

1. **Draw on students' prior experience with electromagnetic forces and introduce the purpose of the next activity.**
   - Say: We have just done an activity with permanent magnets. These are objects that always have a magnetic force.
   - Question: Does something have to be a permanent magnet to have a magnetic field?
   - *Answer: (Allow students to discuss their ideas about this.)*
   - Question: Have you ever combed your hair on a cold day and observed some of your hairs stick up or are pulled toward the comb?
   - *Answer (Students may have experienced this before. If not, you could describe other situations, such as rubbing a balloon on hair so it sticks to the wall.)*
   - Question: What makes your hair stick up or the balloon stick to the wall?
   - *Answer: A force causes something to move or change direction.*
   - Say: These are also examples of the same force we see in permanent magnets, only they occur with objects that are not permanent magnets. Today, you are going to see if you can make a nail into a magnet and then decide how this is like the Earth.

     Note to Teacher: According to the national education standards and the wealth of research on which these standards are based, it is not age appropriate to discuss the composition of atoms with this age group. Therefore, we have the challenge of teaching electricity and magnetism without talking about electrons directly. The following information is, therefore, to provide background information to you as a teacher but is not meant to be shared with students.

     Electrical charge is caused when an object's atoms have too many electrons, creating a negative charge, or too few electrons, causing a positive charge. When we comb our hair, the comb gains electrons from the hair, causing it to be negatively charged and causing the hair to be positively charged. The comb will then attract the hair since it has electrons that the hair "wants."

2. **Introduce students to the Making a Magnet Activity.**
   - Provide each individual or pair of students with a nail and iron filings.
   - Have students try to pick up the iron filings with the nail.
   - Question: Is the nail magnetic? How do you know?
   - *Answer: No, it's not magnetic, because there is no force attracting the iron filings.*
   - Ask students if they were given copper wire and a battery how they would make the nail into a magnet. Have them describe their predicted method in the Hypothesis/Prediction section of their Astro Journals.

     Opportunity for Open Inquiry: You might make this a more open inquiry exercise by making many different kinds of materials available to students and allowing them to experiment to see what materials make the nail magnetic or to observe what variables affect the strength of the magnetic force. You could provide wire made of different metals and varying thickness, nails of different materials and sizes, and batteries of different materials and sizes.

Note to Teacher: When working with batteries, it is not safe for students to put them in a fire or microwave, or to hit them with a hammer. Also, batteries are generally considered to be hazardous waste and should disposed of accordingly.

- Provide each individual student or pair of students with copper wire and a battery. Allow them to explore how to make the nail into a magnet. Have them draw and record their results in the Data Collection section of their Astro Journals.

  Note to Teacher: If some students are unable to make their nail into a magnet after some time, conduct an informal discussion with the class to ask those who were successful to share their techniques so that all students have the chance to make a successful magnet. The best way to do this is to tightly wrap the copper wire around the nail and then connect each end of the wire to opposite ends of the battery.

- Have students answer the questions in the Results/Conclusions section of their Astro Journals.

Explain — Part 2 - (approximately 10 minutes)

1. Discuss student results.

- Question: How were you able to make the nail into a magnet?
- *Answer: We were able to make a magnet by wrapping the copper wire around the nail and connecting each end of the wire to one end of the battery.*

- Question: Did the nail behave like a magnet when just one end of the copper wire was connected to the battery?
- *Answer: No. It only behaved like a magnet when both ends of the wire touched the battery.*

- Question: What other things did you try that did not work?
- *Answer: (Allow students to share their techniques. Some may have found that loosely wrapping the wire, or only wrapping it around a few times did not allow the nail to become magnetic.)*

- Question: So what can we conclude is important for making the nail magnetic?
- *Answer: The wire needs to be tightly wound around the nail many times and connected to both ends of the battery.*

- Question: What do you think is happening to the nail to make it magnetic?
- *Answer: (Allow students to discuss their ideas about this.)*

- Question: What is the purpose of a battery?
- *Answer: Batteries store electricity that can provide power to electronic devices.*

- Question: So what did the battery do in this experiment?
- *Answer: The battery sent an electrical current through the wire.*

- Question: So what can you conclude causes the nail to become temporarily magnetic?
- *Answer: The electrical current around the nail causes it to become temporarily magnetic.*

- Question: What can you conclude about magnetism and electricity?
- *Answer: Electricity and magnetism are related.*

Extend/Apply Part 2 (approximately 15 minutes)

1. Connect the Making Magnet Activity to the Earth.

- Question: In the Geology Training module, what did you observe allowed Earth to have a magnetic field?
- *Answer: The Earth's liquid outer core allows it to have a magnetic field.*

- Question: The Earth is far too hot to have a permanent magnet inside, so how is it possible that it has a magnetic field?
- *Answer: (Allow students to discuss their ideas about this.)*

- Question: What analogy can you make from the Making Magnet Activity to the Earth?
- *Answer: The Earth is like the nail. When electricity flows in the Earth or the nail, it generates a magnetic field.*

- Question: What do you know about the kinds of things that allow electricity (and heat) to flow easily through them?
- *Answer: Metals and water allow electricity and heat to flow easily through them. Wood, ceramic, and plastic resist the flow of electricity and heat through them.*

  Note to Teacher: If students are not familiar with conduction and insulation, you may want to spend some time on this topic. Draw on students' prior knowledge with cooking utensils that heat up quickly compared to those that do not.

- Question: So what is it about the inside of the Earth that would allow electricity to easily flow inside it?
- *Answer: The outer core is largely composed of iron, which is a metal that would allow electricity to easily flow around the inner core of the Earth.*

- Question: What part of the Making Magnet Activity is like this outer core?
- *Answer: The wire is like this outer core.*

- Question: Is there a battery connected to the outer core to provide the electricity?
- *Answer: No, there is no battery connected to the Earth.*

- Question: Then, what causes the electricity to flow around the inner core?
- *Answer: Because the outer core is liquid, when the Earth rotates, it causes the outer core to also move around which generates electricity around the inner core.*

2. Discuss the magnetic field debate with students.

- Say: Scientists do not agree on whether the Earth's magnetic field is essential for human survival. Some believe that the atmosphere would provide enough protection if we lost our magnetic field, while others feel that losing our magnetic field would be devastating to life on Earth. Scientists do not have enough evidence to say one way or another. More research needs to be done in this area.

- Question: What does this tell you about the nature of science?
- *Answer: (Allow students to discuss their ideas about this. Students may observe that science is based on evidence that can sometimes be interpreted differently, that science evolves with time, and that there are still a lot of questions that need to be answered.)*

- Say: Science is like solving mysteries. There are still so many mysteries that need to be solved. Maybe, one day, you can help to solve them!

Evaluate (approximately 15 minutes)

1. Have students answer the Magnetism and Life Final Questions in their Astro Journal.

2. Discuss students' responses to their Astro Journals to ensure they have mastered the major concepts.

- Question: What dangers does the Sun present to human life on Earth?
- *Answer: The Sun produces harmful particles that are thrown toward the Earth through solar wind and flares. These particles can cause cancer and mutations.*

- Question: How is human life on Earth protected from these dangers?
- *Answer: The Earth's atmosphere and magnetic field protect life on Earth.*

- Question: How is Earth's magnetic field generated?
- *Answer: The Earth's magnetic field is generated because the liquid outer core moves as the Earth rotates. This causes electricity to flow through the outer core, which creates a magnetic field around the Earth.*

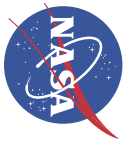
3. Collect students' Astro Journals and evaluate them to ensure they have each mastered the major concepts.

- The Sun produces the solar wind that is made of fast-moving particles that could harm us by causing cancer and mutations.
- Magnets can exert a force on each other.
- Magnets generate a force around themselves called a magnetic field.
- Magnetism is caused when atoms are all pointed in the same direction.
- As the Earth rotates, it causes the outer core to move, which is possible because the outer core is liquid.
- The amount of movement of this outer core is enough to generate a strong magnetic field around the Earth.
- This magnetic field and the Earth's atmosphere shield the Earth from the harmful solar wind.
- Scientists do not agree whether or not life could survive on Earth without its magnetic field, as our atmosphere may provide sufficient protection.

4. Bridge to next lesson.

- Say: Today, we learned how Earth's liquid outer core generates a magnetic field that helps to protect the Earth from solar wind and space particles. In the next lesson, we will summarize our learning of how Earth's structure and processes are important to human survival.

Note to Teacher: After each lesson, consider posting the main concept of the lesson some place in your classroom. As you move through the unit, you and the students can refer to the "conceptual flow" and reflect on the progression of the learning. This may be logistically difficult, but it is a powerful tool for building understanding.



Astro Journal Geology Lesson 7: Magnetic Field and Life

Class/Period:

Scientific Question:

How is the Earth protected from solar particles?

1. Hypothesis/Prediction: How do you think Earth is protected from solar particles? Why?

Name:

Date:

Exploring Magnets Activity

2. Hypothesis/Prediction: Draw and describe the following: When two magnets have north and south sides toward each other, what will happen? Why?

Astro Journal Geology Lesson 7: Magnetic Field and Life

Name:

Class/Period:

Date:

3. Draw and describe the following: When two magnets have their north sides toward each other, what will happen? Why?

4. Draw the pattern that you think will occur when iron filings are sprinkled over a magnet. Explain why you think this pattern will occur.

Astro Journal Geology Lesson 7: Magnetic Field and Life

Name:

Class/Period:

Date:

Results/Conclusions

5. What did you observe and feel when you moved the north side of a magnet near the south side of another magnet?

6. What did you observe and feel when you moved the north side of a magnet near the north side of another magnet?

7. Did one magnet change the speed and direction of the second magnet? Explain.

8. Draw the pattern made by the iron filings when sprinkled over a magnet.

9. Was anything touching the iron filings to make them move into the pattern around the magnet?

10. What caused the second magnet and iron filings to change speed and direction?

Astro Journal Geology Lesson 7: Magnetic Field and Life

Class/Period:

Name:

Date:

11. What can we conclude about magnets?

Making a Magnet Activity

1. Hypothesis/Prediction: Draw and describe your predicted method for making a magnet with a nail, copper wire, and a battery. Why do you think this will create a magnet?

2. Hypothesis/Prediction: Draw each method that you used to try to make a magnet. Describe the result of each trial.

Trial Number	Drawing	Result

Astro Journal Geology Lesson 7: Magnetic Field and Life

Class/Period:

Name:

Date:

Results/Conclusions

3. How were you able to make the nail into a magnet?

4. What do you think is happening to the nail to make it magnetic?

5. What can you conclude about magnetism and electricity?

Magnetism and Life Final Questions

1. What dangers does the Sun present to human life on Earth?

2. How is human life on Earth protected from these dangers?

3. Draw and describe how Earth's magnetic field is generated.